2005 ALCPG & ILC Workshops – Snowmass, U.S.A.

Concluding Remarks

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The ILC Workshops at Snowmass have been a great success in 2005, with progress on many fronts, including the physics, the machine, the detectors, and communications, education and outreach.

1. INTRODUCTION

Nearly 150 years ago, bold people came to Colorado from around the world in search of gold buried in the Rocky Mountains. They were searching for the treasure of their time. Today we seek a different treasure: an understanding of the fundamental laws of nature. During the past two weeks, our world-wide community (more than 668 strong) has come once again to the Rockies, planning for discovery of this modern-day treasure.

We expect fascinating revelations from our mysterious universe. Recent discoveries have revolutionized our picture of its nature, yet numerous, critical, unanswered questions remain to be addressed:

– What is the nature of the universe and what are its components?

– What are matter, energy, space and time?

– How did the universe get here and what is its future?

While we have many remarkable theoretical models, we are without a comprehensive theoretical understanding of what we observe. Experiment must now take the lead. Particle physics has never been so compelling.

The ILC will present many discovery opportunities. These include precision measurements of the Higgs boson, including its branching fractions, mass, and width. We may measure the dark matter candidate particles' masses and couplings, or the couplings in strongly interacting scenarios. The physics chosen by nature will determine the character of these discoveries. What is certain is that there is an unknown secret character of the fundamental forces lurking at the TeV scale.

2. ADVANCES IN PHYSICS AT SNOWMASS

Our colleagues within the physics working groups have been active at Snowmass refining and advancing the physics case for the ILC. We have heard the summaries of this progress in the review talks. They include the studies of the Higgs bosons, supersymmetry, physics beyond the standard model, top physics and quantum chromodynamics, LHC/ILC connections, cosmological connections, and radiative corrections (which were the concern of the Loopfest workshop).

The physics case for the ILC has been compelling for a long time. The underlying physics of electroweak symmetry breaking requires precision measurements that only the ILC can produce. Electroweak precision measurements tell us that within the context of the Standard Model, the mass of the Higgs boson must be less than about 200 GeV/c^2. The ILC provides an arsenal of tools to attack the exploration of this physics, including small backgrounds, precise flavor

tagging, detection of invisible decay modes, and polarization. The physics working groups have developed a good understanding of how to exploit these tools, and to maximize the discoveries of the ILC.

3. GLOBAL DESIGN INITIATIVE AND THE GDE

This past year has seen the establishment of the Global Design Initiative, with a distributed "laboratory" for the ILC, the Global Design Effort (GDE), and a director, Barry Barish. This globally coordinated effort is moving us towards our goal to produce the tool we need to explore the grand questions of the Universe. The plan and schedule of the GDE is illustrated in Figure 1. The current year's effort is to produce the baseline configuration by the end of 2005. Here at Snowmass, significant progress on the Baseline Configuration Document has been achieved. Next year, attention will turn to the reference design, with a Reference Design Report planned for the end of 2006.

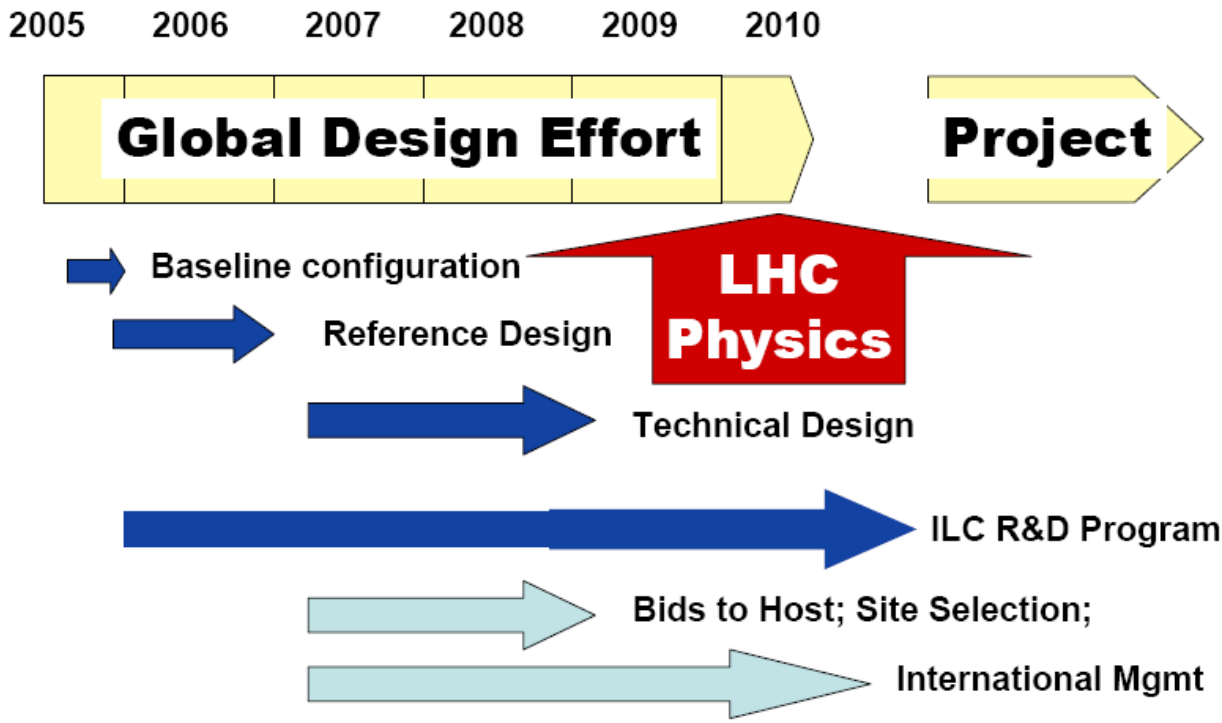

Figure 1: The GDE Plan and Schedule

4. THE DETECTOR CONCEPTS

The detector concept efforts are growing and have made good progress here at Snowmass. The three major concepts, GLD, LDC, and SiD, were active with dedicated workshop meetings, and in the subdetector working groups. A new concept was introduced at the end of Snowmass.

The GLD and LDC concepts are built around TPC trackers. SiD employs silicon tracking, and the strongest solenoidal field of 5 Tesla. Further details of these concepts are described in the plenary talks of Satoru Yamashita, Dean Karlen, Hiro Aihara, Yasuhiro Sugimoto, Ties Behnke, Andy White, and John Hauptman.

5. GDE – 2006 PLAN, AND THE DETECTOR CONCEPT REPORT

As was already stated, the baseline configuration that is developed this year will lead into the preparation of a Reference Design Report at the end of 2006. This report will be one of a three volume set, which is also planned to include a shortened, executive summary for non-experts and policy makers, and a Detector Concept Report (DCR), describing the detectors which could achieve the physics program of the ILC. The DCR is also planned to present the physics program of the ILC. The World Wide Study is preparing the Detector Concept Report volume, and preparation for that begins with the presentation of a Detector Outline Document by each detector concept study team at the Bangalore LCWS in March, 2006. The contents of the Detector Outline Documents[1] will include the following:

- The Physics Program
- Description of the detector concepts
- Performance estimates with respect to physics benchmarks
- Required R&D and the status and plans for R&D
- Rough cost estimate of an ILC detector

Beyond this milestone, we can anticipate the call for real detector conceptual design reports a couple of years later.

Our R&D efforts, particularly the study of the detector concepts, depend heavily on the support of our colleagues doing the simulation effort. We are being well served by many efforts, under the leadership of Ties Behnke, Norman Graf, and Akiya Miyamoto. This is hard work, and critical, and we appreciate their efforts to provide the infrastructure which is essential to our progress.

6. CASE FOR TWO COMPLEMENTARY DETECTORS

During the Snowmass workshop, we had a discussion of the case for two complementary detectors, which is compelling, but threatened by available funding. The statement of the case is presented elsewhere in these proceedings.[2] The arguments fall into several categories:

- Confirmation and Scientific Redundancy
- Complementarity, Collider Options
- Competition
- Efficiency, Reliability, Insurance
- Sociology, Scientific Opportunity
- Historical lessons

We will continue to develop our understanding of the value of two complementary experiments, and to express it clearly to our colleagues and beyond.

7. DETECTOR R&D

Detector R&D now holds a central role in our efforts. There was much discussion and progress during the workshop on all aspects of the detector R&D. Experts on vertexing, tracking, calorimetry, muon/particle-id, data acquistition, physics and detector simulations, interaction regions and backgrounds, IP beamline instrumentation, test beams, and particle flow algorithms engaged in intense sessions and discussions. Advances ensued.

Funding for detector R&D is increasing within the global community, but lags behind the needs in some countries, notably the U.S. The World Wide Study has created a Detector R&D Panel chaired by Chris Damerell to collect information on the on-going projects, world-wide, and to strengthen the coordination and prioritization of the activities. The R&D Panel is preparing an R&D report to accompany the GDE machine Baseline Configuration Document later this year. The Panel is drawing input for this report from the R&D teams, and the concepts.

Progress on detector R&D is limited by prototype construction and beam tests, and planning has been an on-going concern by the WWS test-beam working group, which has been active at Snowmass.

In the U.S. university detector R&D funding for FY05 has been $700,000 from the DOE, and $117,000 from the NSF. This program involved 25 universities on 24 projects.

8. TALE OF TWO COLLIDERS

There was much discussion at Snowmass on the relationships between the LHC and the ILC. The success of the LHC will be a big boost to our field and to our ILC aspirations.

Joe Lykken told us about the HEPAP ILC/LHC Report, "Discovering the Quantum Universe: the Role of Particle Colliders." The LHC and the ILC will address many great scientific questions of our day, and together they form a powerful partnership. The report dispels the mistaken notion that the more the LHC discovers, the less there is for the ILC; just the opposite is the case, as this report spells out.

We are now moving ahead aggressively in our preparation for the ILC experimental program. Once we have collisions at the ILC, an exciting synergy with the LHC will be realized.

9. COMMUNICATIONS, EDUCATION, AND OUTREACH

Communications, education and outreach were an active enterprise at Snowmass. The ALCPG activities, led by the Marge Bardeen, engaged many of the physicists as volunteers contributing to several successful initiatives. These included the display of the Quantum Universe in Snowmass Village and on the Aspen Mall, dark matter and detector workshops, and public lectures by Young-Kee Kim, on "$E = mc^2$: Opening Windows on the World," and by Hitoshi Murayama, on "Seeing the Invisible – Challenge to 21st Century Particle Physics and Cosmology."

The GDE Communications and Outreach group, initiated at the First ILC Workshop at KEK last November, met here during the workshop, advancing and strengthening their global coordination and initiatives.

We brought our exciting ambitions to the public, and we learned new approaches to advance our outreach activities for the future.

10. CONCLUSIONS

Our Workshop has been very fruitful. We have studied and advanced the compelling physics case, refined the accelerator design, advanced our plans for the experiments through discussions and calculations of detector R&D and concept design, and engaged the broader community through education and outreach. Having the full community together (physics, detectors, and machine) has led to significant progress at the interfaces between the efforts. We are approaching the treasure. We have taken many positive steps in the past few years. The pace is picking up. We have come far, but have a lot of work left. Let's do it!

Thank you all for making this regional workshop a global success.

Acknowledgments

Many have contributed to the organization and execution of this workshop. I would like to acknowledge the vital contributions of Cynthia Sazama and her team in the Secretariat from Fermilab and SLAC. Cynthia joined our planning early, and guided us over many hurdles before and during the workshop. A team from Cornell, Fermilab, Colorado, LBNL, and SLAC, led magnificently by Ray Helmke, and John Urish, provided excellent networking and computing support. Professional preparation by this team resulted in a smooth, well supported, service. The committees and working group leaders did an excellent job of organizing the program. Shekhar Mishra and Nan Phinney provided critical coordination in representing the accelerator community on the local organizing committee. And I am particularly indebted to my three colleagues who contributed most to the planning of the workshop, ILC Workshop co-chairs Ed Berger and Uriel Nauenberg, and ALCPG co-chair Mark Oreglia.

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References

[1] http://physics.uoregon.edu/~lc/wwstudy/concepts/outline-specs

[2] James E. Brau, T. Omori, Ronald Settles, "Arguments for Two Complementary Detectors at the ILC," these Proceedings.